May 7, 2018

To: DOH and EPA Technical Team

From: Matt Tonkin & G.D. Beckett

Subject: LNAPL Source Term Evaluations for the Red Hill Tank Farm Area

Objectives: Our key objective is to undertake some initial steps in the evaluation of the potential LNAPL mass distribution in the aquifer in the area of Red Hill Tank Farm, and to bracket the dissolved-phase transport properties of the aquifer system. In particular, we would like to understand how far "downstream" of the tank farm LNAPL has potentially been transported to result in the observed impacts at Red Hill shaft drinking water well.

Approach: We will request the current groundwater modeling parameter data set from the Navy, and failing rapid delivery of that, will populate our model using other Navy sources and literature assumptions (as necessary). With those parameters, we will create a matrix from which different source term models can be executed. We will vary only the most significant parameters. One parameter of particular interest in this analysis will be the hydraulic gradient, and the role that it plays in determining the Darcy velocity. We will then use the API 4715 approach to LNAPL source term modeling to evaluate scenarios that generate low level impacts of dissolved-phase jet fuel constituents. We anticipate approximately 25 model simulations.

Level of effort: We expect the level of effort to require about 3 days each of Matt & G.D.'s time (approximately 50-hrs total). That will include the preparation of the parameter ranges, modeling matrix, and modeling runs. Appropriate parameter ranges will be discussed with Bob Whittier and Don Thomas. This will be a first-cut effort, upon which we may ask additional questions and run further analyses not inclusive in this limited scope.

Discussion: The Red Hill shaft drinking water well is approximately 2,650-ft (~0.5-mile) downstream of the Red Hill Tank Farm, at least according to the Navy's groundwater model, as measured from the center line between Tanks 1 & 2 and Navy well RHMW2254-01. The Tank Farm itself is about 1,900-ft in length along its axis up-ridge from the Red Hill shaft (maximum travel distance of ~4,500-ft). In a groundwater system with a large attenuative capacity, like we believe of this one, that is an unusually large distance (between 2,650 and 4,500-ft) for transport of contaminants that exhibit some attenuation characteristics, particularly considering the dilution that likely occurs along that travel distance and with the shaft itself. While the analyte concentrations are low level (see the attached Navy data table), the repeatability of detections suggest this area is at the distal end of contaminant transport relative to the Tank Farm. One of flaws in the Navy's LNAPL modeling is that they do not fully embrace the LNAPL source condition ranges that would have to exist in order for the observed transport to have occurred.

Halawa Shaft drinking water well is approximately 4,500-ft to the northwest, and though it is likely located more transverse to the primary direction of flow and contaminant migration from the Tank Farm than is Red Hill shaft, the available evidence from Red Hill shaft suggests that fuel components may

migrate several thousand feet through a combination of LNAPL and dissolved transport. Further, there have also been low-level contaminant impacts in some wells to the northwest, as shown in Figures 1 & 2. While the actual analyte concentrations have inherent uncertainty, the detections themselves are likely real, or at a minimum, should be considered such in a conservative analysis of the source and transport system. Observing a transport distance of between 2,650 and 4,500-ft to Red Hill shaft is therefore a rather concerning observation given that the Halawa Shaft is only 4,500-ft distant. With the inherent uncertainty in the Navy's modeling approaches (groundwater and LNAPL), it is important to consider the implications of this observed transport so that we may provide the Navy with a more thorough framing of our concerns. For instance, if LNAPL migration under new release conditions was downslope to the northwest, this could introduce a contaminant source in closer proximity to the Halawa Shaft. There is some distance of LNAPL transport under which there will be a potential threat to that drinking water resource; neither we nor the Navy know what that might be and this effort will provide some general framing for consideration of those scenarios.

The selected model, API #4715 (also a tool in the API Interactive LNAPL Guide, 2004), allows one to input an LNAPL source mass for any type of petroleum product. There is a default for jet fuel that would be our starting fuel type. The model allows a simple LNAPL source mass geometry to be input, and then that source feeds dissolved- and vapor-phase mass partitioning and transport from that static mass. In our analysis, we will need to vary the source mass distribution within the other related transport parameter ranges until we get a "fit" for the travel distance to Red Hill Shaft. That will then provide a range of potential LNAPL-source distribution conditions that are consistent with the observed transport to Red Hill Shaft.

We do not expect a highly refined model set, as the method is simplified (semi-analytic), and further, there are many uncertainties in the LNAPL and groundwater transport system at this site. But the approach will give us what the Navy team has not, which is a set of internally consistent and conservative scenarios for what the LNAPL mass distributions might be in the aquifer. Given that the plume is uncharacterized by the very sparse monitoring and sampling network along Red Hill ridge and Tank Farm, this will provide a context for how past LNAPL releases may have been transported in the system. At a later time, we could extend the evaluations to consider what new mass added to the existing ranges might imply to contaminant transport and the threat to drinking water resources.

For efficiency's sake, the work product from this effort will be in slideshow format, presented to the regulatory agencies and their consultants. Results may then be used as a basis for discussions with the Navy and its consultants regarding the differing interpretation of plausible subsurface transport.